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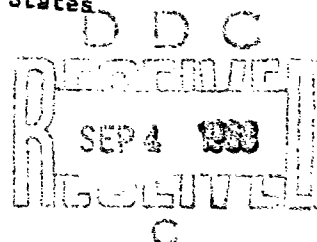
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THE HARD WHEAT IN GREECE

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SUMMARY

Around the year 1930, the varieties of hard wheat accounted for about 70% of the total wheat-growing area. Since that time, and due to the development of improved, high-yield varieties of soft wheat, this percentage has dropped to 28%, representing today about three million stremmata [1 stremma is equal to about 1/4 of an acre] with an annual yield of 450,000 tons.

In view of the international demand of hard wheat, an effort is being made to increase the production of hard wheat for export purposes. This effort must be based on the varieties Limnos, I-58128, and I-5830I, which give yields higher by 30% than the rest of the varieties cultivated today in Greece, and also are qualitatively superior.

Moreover, the varieties of hard wheat must be given preference over the soft ones in areas carefully selected as more suitable for them. The use, to some extent, of hard wheat by the Greek farmers for bread-making must be avoided.

INTRODUCTION

During the last few years, an increased demand for hard wheat is observed all over the world. This must be attributed to two main reasons:

- a) The fact that there is an increased consumption all over the world of the products obtained from hard wheat, i.e., of semolinas and macaroni-like products in general.
- b) The fact that the world production of hard wheats shows a decline in terms of both acreage and total yield.

An effort is being made to counteract this deficit in the world production of hard wheat by increasing its cultivation at the expense of the soft one, and by increasing its average yield per acre. As a result of this effort to counteract the world deficit of hard wheat, all countries capable of growing hard wheat have organized programs for the expansion and intensification of its cultivation and production. Thus, for instance, in the United States, in Canada, and in Australia, namely in the most important wheat-producing and exporting areas of the world, the world deficits of hard wheats have been taken into consideration and programs have been initiated aiming at an increased production of hard wheats to overcome the existing deficits.

In Italy, which as a neighbor, our country follows closely, the subject has been under study for the last few years and an effort is under way to reduce the country's deficit in hard wheat products. Already, after two local conferences for the study of the subject which took place in Italy in 1958 and 1960, an International Conference was organized in May of this year on the cultivation of hard wheat. The purpose of this Conference was to study and arrive at conclusions on the methods to be followed for the increase of the yields and the improvement of the quality of the hard wheats, in order to achieve a substantial increase in their production.

In our country the cultivation of hard wheat is following the same decreasing trend which is observed all over the world; the areas where hard wheats are cultivated keep gradually decreasing every year. However, as a consequence of the recent connection of our country with the European Common Market and of the shortage of hard wheats in the countries that comprise it, a possibility is created for the export of large quantities of hard wheat. This possibility dictates the expansion of the cultivation of hard wheats to an extent proportional to the circumstances. In view then, of the possibility of exports of hard wheat to the countries of the European Common Market, the Ministry of Agriculture is programming this year, very correctly, an enhanced cultivation and an increased production of such wheats. The purpose of the present study is to examine the course followed by the cultivation of hard wheat in Greece, to analyze the causes contributing to the considerable decline in their cultivation observed in recent years, and to reach certain conclusions as to the measures to be taken for a renewed stimulation of the cultivation of hard wheat and an increased production. This can be achieved by a) expanding its cultivation in soils, and ecological areas in general, where such expansion is possible by the use of new varieties which give higher yields and are technologically superior, and b) applying in a large scale improved technical methods which definitely contribute in both increased yields and improved quality.

GENERAL

When we speak of the varieties of hard wheat (meaning those, a grain section of which, has a glassy appearance) which are cultivated in Greece, we must keep in mind that they belong exclusively to the species Triticum Durum, while the Greek varieties of soft wheat (meaning those, a grain section of which has a floury appearance) belong almost exclusively to the species Triticum Vulgare.

In the past, there used to be cultivated in small scale in Greece some varieties with hard (glassy) grain belonging to the species Tr. Polonicum, and some varieties with soft (floury) grain belonging to the species Tr. Turgidum. However, today, the Tr. Polonicum is not cultivated any more and the Tr. Turgidum also tends to disappear from the Greek wheat cultivation.

We must also keep in mind that whereas the hard wheats are characterized as spring wheats and are usually sown all over the world in the spring, in Greece and the other Mediterranean countries, because of the mild climate, sowing takes place, almost as a rule, in the fall, in the same manner as for the soft wheats. The varieties characterized as "two-month's" or "three month's" which are sown in the spring constitute a negligible percentage.

GENERAL FEATURES

The two species of wheat which predominate in Greece are genetically different, having a different number of chromosomes. In the haploid form $n = 14$ chromosomes for Tr. Durum and $n = 21$ for Tr. Vulgare. For this reason a cross between varieties of the two species results in a certain percentage of infertility, whereas between varieties of the same species a cross is always fertile. It is believed that the number of chromosomes of the various varieties of wheat, which is always a multiple of 7, has arisen from various original species, having genomes of 7 chromosomes each, by crossing and polyploidy.

Thus the hard wheats having $n = 14$ chromosomes (2×7) in their haploid form are considered to contain the simple genomes A and B (of 7 chromosomes each) of two original species, namely of Triticum Monococcum (A) and Aegilops Speltoides (B), while the soft wheats with 21 chromosomes contain, in addition to the above two genomes A and B, the genome D of a third species which has been identified as the Aegilops Squarrosa, also with $n = 7$ chromosomes in its haploid form, according to Sears, Sarkar and Stebbins.

As for their origin, N. Valilov maintains that the initial cradle of hard wheat was Abyssinia and the Mediterranean Africa, while that of soft wheat is considered to be Persia and the part of India near the Himalayas. The fact is that both species were known and cultivated in the prehistoric years by the peoples around the eastern Mediterranean, and that the word s i t o s [wheat] appears to be of Semitic origin.

MORPHOLOGICAL FEATURES

In addition to the already mentioned hardness (hyaline texture) of the grain, the hard wheats differ morphologically from the soft ones by the appearance of the spike. Thus, the spike of the hard wheats is wider at the sides, so that its front (the position of the spike in which only one series of spikelets is visible) is always narrower than, or equal to the side (the position of the spike in which both series of spikelets are visible), whereas in the soft wheats the spike is wider at the front, so that the latter is always wider than, or equal to the side. A fact contributing to this different appearance of the spike is that the hard wheats mature up to four grains per spikelet, whereas the soft wheats mature up to six grains per spikelet; for this reason the spikelets of the latter have more width (wider front).

The spikelets of the hard wheats are closer to each other than those of the soft wheats. Thus the spike of the hard wheats is shorter and more compact.

In addition, the spikes of all varieties of hard wheat cultivated in Greece bear awns, usually long, in contrast to the soft wheat, some varieties of which bear awns usually shorter than those of the hard wheat, and some others no awns at all.

PHYSIOLOGICAL FEATURES

From the physiological point of view, the varieties of hard wheat cultivated in Greece today are definitely more late-ripening than those of the soft wheat. For this reason they are subject to unfavorable conditions during ripening (hot winds, etc.). They also have weaker stems and are taller in the final phase (from fertilization on) and consequently they are more susceptible to lodging than the soft ones. Both of these disadvantages contribute to the lower yield of the hard wheats in comparison to the soft ones. In general, the hard wheats thrive better in dry, hot areas and are harmed by excessive humidity.

Since in our country a higher natural moisture content of the soil usually coincides with greater fertility, we can say that, in general, the soft wheat is better suited for such soils, whereas the hard one is more suitable for soils of lesser fertility and of lower moisture retaining

capacity. This does not mean that the hard wheat cannot also thrive in very fertile soils found in areas of lower rainfall and not capable of retaining much moisture.

Moreover, an unfavorable factor for the cultivation of hard wheat in our country is the harshness of the winter in certain areas (like, for instance, Western Macedonia, some areas by the River Evros, and, in general, areas of high altitude all over the country). In such areas, hard wheat can be damaged much more than soft wheat by subfreezing temperatures.

In conclusion then, the hard wheat in our country is in its right place when sown in semi-fertile or little fertile and rather dry fields - which constitute the majority of the wheat-growing fields in Greece - in the warmer parts of Northern Greece and in all of Middle and Southern Greece and the Islands. Thus, there are vast possibilities for an expansion of its cultivation at the expense of the soft wheats.

USES OF THE HARD WHEATS - TECHNOLOGICAL PROPERTIES

The hard wheats are used for the production of semolina, macaroni, and other similar products used as food, in contrast to the soft wheats which are used for the production of flour for bread-making. This can be attributed to the fact that, because of the hardness of their grain, due in turn, to the different structure of their endosperm, they are not pulverized (to flour) to the same degree as the soft wheats during milling, but give rise to a material more coarse and compact, the semolina, suitable for the macaroni industry. Also, the hard wheats have a higher protein content than the soft ones, a quality especially desirable in the macaroni industry.

A common occurrence in our country is the use by the farmers of hard wheat for bread-making, while the bread consumed by the city population comes exclusively from soft wheats. The farmers using hard wheat for making bread maintain that the bread made from hard wheat is better than that made from soft. This impression of our farmers is due more to the fact that the consumption of hard wheat bread is a long-time habit of theirs, than to an actual qualitative superiority of such bread. It is universally accepted that hard wheat is less suitable for bread-making than soft wheat, as, on the other hand, the latter is less suitable than the former for the macaroni industry.

Supporting this view are the results of a study of the bread-making value of the Greek wheats which is being conducted in the Chemical Laboratory of the Grain Institute. In Table I below we give a few characteristic data, taken from the results obtained so far in this study, about the quality, from the point of view of the bread-making value, of the main varieties of Greek wheats.

Table I
Bread-Making Value of Greek Wheats

Varieties	Quality of Gluten	Amount of wet Gluten %	Valory-metric number	Bread-making number
Soft wheat				
I - 46025	Elastic	25 - 35	40	46
I - 38290	Elastic	18 - 28	49	41
Mentana	Medium elastic	22 - 32	37	36
Hard wheat				
Limnos	Flowing	26 - 36	28	28

According to the data in Table I, the Greek wheats have, generally speaking, a moderate bread-making value, but in particular, our soft wheats are definitely superior than the hard ones as far as bread production is concerned. And if we take into account the fact that in Greece the price of hard wheat is higher than that of the soft, it becomes clear that those using hard wheat for bread-making are eating bread of a lower quality and a higher price than the bread made of soft wheat.

THE COURSE FOLLOWED BY THE CULTIVATION OF HARD WHEAT IN GREECE IN THE LAST THIRTY YEARS

Statistical data on the wheats cultivated in Greece were kept only since 1931. Unfortunately, data concerning the particular varieties of wheat were not kept every year together with those on acreage and yields. As far as we know, such data are available only for the cultivation years 1930-31, 1933-34, 1938-39, 1945-46, 1956-57, 1957-58, and 1958-59.

The data up to the year 1945-46 cover only the acreage cultivated with each variety, while for the last three years (1957-59), in addition to the acreage, there are data on the yields of each variety.

The collection of such data begun at a time at which our country decided to follow a policy of expansion and intensification of wheat-growing, in order to cover the needs in bread of our population from local sources to an always larger extent. The purpose of this statistical work was to follow the progress in the cultivation of improved varieties of wheat, which had been imported from abroad or created in the Grain Institute.

Although these data are discontinuous, covering only seven out of the thirty years of the period 1930-1960, they give a true picture of the redistribution of the varieties and, in general, of the hard and soft wheat during this thirty year period. The data are presented in Table II.

Table II

Areas (in Stremmata) Cultivated with Hard and Soft Wheats

Years	Hard wheats	Soft wheats	Unspecified wheats	Total wheat-growing area
1930-31	3,717,183	1,260,221	599,213	5,576,617
1933-34	4,756,232	2,611,797	972,598	8,340,627
1938-39	4,495,095	4,419,411	643,089	9,559,595
1945-46	3,678,150	3,802,105	291,296	7,772,251
1956-57	3,329,784	7,063,183	597,113	10,990,080
1957-58	3,214,066	7,563,054	547,579	11,324,699
1958-59	3,077,389	7,769,851	786,311	11,633,551

The data of Table II become clearer and easier to perceive, if expressed as percentages of the total wheat-growing area for each year, as shown in Table III.

TABLE III

Areas Cultivated with Hard and Soft Wheats Expressed
as Percentages of the Total Wheat-Growing Area

Years	Hard wheats	Soft wheats	Unspecified wheats
1931	66.66	22.60	10.74
1934	57.02	31.31	11.67
1939	47.04	46.23	6.73
1946	47.32	48.92	3.76
1957	30.30	64.27	5.43
1958	28.30	66.78	4.84
1959	26.45	66.79	6.76

The data in Tables II and III indicate that in our country, in 1931, the hard wheats were occupying the two thirds of the total wheat-growing area. Since that time they are constantly and steadily being displaced by the soft wheats, so that they only cover today an area smaller than the one third of the total.

We are not in possession of any data on the areas cultivated with hard wheat all over the world to compare them with ours. We note, however, that in Italy, which from the point of view of both soil and climate, most closely resembles our country, the hard wheats occupied, in the period 1954-57, 28.6% of the total wheat-growing area, a percentage which is in striking agreement with that observed in our country during the same period.

The main varieties of hard wheat cultivated in our country in recent years (data of 1958) are shown in Table IV.

Table IV

Main Varieties of Hard Wheat and the Respective Occupied Areas

Varieties	Area (in stremmata)	Percent of the total wheat- growing area
Eretria	220,502	1.95
Limnos	1,179,389	10.41
I - 46049	88,252	0.78
S. Capelli	245,588	2.17
Ak Basak	315,454	2.79
Asprostaro	331,600	2.93
Gremmenia	84,150	0.74
Kokkinostaro	47,299	0.42
Kontouzi	76,472	0.68
Mavragani	301,756	2.66
Monologi	51,900	0.46
Bos Basak	30,000	0.27
Deves	25,855	0.23
Sari Basak	31,327	0.28
Trimini and Dimini	27,314	0.24
Miscellaneous	157,208	1.37
Total	3,214,066	28.38

REASONS FOR THE OBSERVED REDISTRIBUTION

The beginning of the thirty-year period under examination, 1930-1960, coincides with the beginning of the development of improved varieties of wheat which, although very little used before 1930, occupy today, as shown in Table V, the 3/4 of the total wheat-growing area.

Table V

Areas Occupied by Improved Varieties of Wheat

Years	Stremmata	Percent of total wheat-growing area
1931	246,383	4.42
1934	1,751,963	21.00
1939	3,007,171	31.46
1946	3,670,990	47.23
1957	7,886,811	71.76
1958	8,337,419	73.62
1959	8,925,664	76.72

Tables VI and VII show, more specifically, the areas occupied by hard and soft varieties; the former within the total of the improved varieties, and the latter within the total of the native varieties.

Table VI
Areas Occupied by Improved Varieties of Wheat

Years	Stremmata		Percent of the total of improved varieties	
	Hard wheats	Soft wheats	Hard wheats	Soft wheats
1931	74,868	171,515	30.39	69.61
1934	144,949	1,607,014	8.27	91.73
1939	450,303	2,556,868	14.98	85.02
1946	1,217,667	2,453,323	33.17	66.83
1957	1,756,247	6,130,564	22.27	77.73
1958	1,736,851	6,600,568	20.83	79.17
1959	1,853,618	7,072,046	20.77	79.23

Table VII
Areas Occupied by Native Varieties of Wheat

Years	Stremmata		Percent of the total of native varieties	
	Hard wheats	Soft wheats	Hard wheats	Soft wheats
1931	3,642,315	1,088,706	76.99	23.01
1934	4,611,283	1,004,783	82.11	17.89
1939	4,046,792	1,862,543	68.48	31.52
1946	2,460,483	1,348,782	64.59	35.41
1957	1,573,537	932,619	62.79	37.21
1958	1,477,215	962,486	60.55	39.45
1959	1,223,771	697,805	63.69	36.31

The data shown in Tables V, VI, and VII lead us to the following conclusions:

- a) The decrease in the cultivation of hard wheats was concomitant to the progressive spreading of the improved varieties.
- b) The native varieties, while continuously decreasing in total occupied area, kept the ratio of hard to soft varieties almost constant at 2 : 1.
- c) The improved varieties, while increasing steadily in total occupied area, also kept the ratio of soft to hard wheats constant at 4 : 1.

Consequently the decrease in the cultivation of hard wheat in Greece can be attributed to the increased cultivation of improved varieties of soft wheat as compared with that of the improved hard varieties.

Unfortunately, we are not in possession of experimental data comparing native varieties of hard and soft wheats nor of data on the yields of the various varieties of wheat cultivated in the whole country before 1956. Therefore, we cannot reach any conclusions regarding the reasons for which the hard wheats were cultivated in the past in our country in an area twice as large as the soft wheats. The only explanation that seems to be close to reality is provided by the estimations of the yields of the various varieties made by the local Bureaus of Agriculture in every Prefecture of the country during the years 1957-1959. The results of these estimations are summarized in Table VIII.

Table VIII

Estimated Yields (in Kilograms Per Stremma) of the Native Varieties of Wheat During the Years 1957-59

Years	Hard wheats	Soft wheats	Unspecified wheats
1957	116.7	113.6	96.6
1958	117.9	118.9	113.0
1959	117.1	107.4	109.9
Average	117.2	113.3	107.5

We observe here that in the three-year period in question, in every year and on the average, the native varieties of hard wheat gave about the same yields with the native varieties of soft wheat. In view of the fact that the price of hard wheat is higher, in our country too, than that of soft wheat, one can deduce that our farmers cultivating hard wheats were right in preferring the hard over the soft wheats. We believe that the data of this three-year period can be taken as more general and that we can safely maintain that the native varieties of hard and soft wheats cultivated in Greece - with the possible exception of a few years unfavorable for one or the other group - have always given yields approximately equal. Consequently, the preference of hard wheats by our farmers, in view of their equal yields to the soft wheats, was due to the higher economic gain, because of the relatively higher price of the hard wheats.

This, in our opinion, explains the higher proportion in the area occupied by hard wheats as compared with the soft ones, observed in Greece in the period preceeding the development of improved varieties.

We come now to the question of the decrease in the cultivation of hard wheats, which, as we have shown, is connected with the faster spreading of the improved varieties of soft wheat as compared with that of the improved varieties of hard wheat. In Tables IX and X and in Diagram 1 we present comparative data from experiments in various parts of the country showing the differences in the yields of the native wheats on one hand, and the improved varieties of both hard and soft wheat on the other. Because it is not possible to present data for each individual, native or improved, variety cultivated today in our country, the tables present data concerning:

- a) For the native wheats, the most common native variety in each area.
- b) For the soft improved wheats, varieties I - 38290 and I - 46025, which during the years 1957-59, represented 73.5% of the total area cultivated with improved varieties of soft wheat.
- c) For the hard improved wheats, varieties Limnos and I - 46049 which represented, in the same period, 73.8% of the total area cultivated with improved hard wheats.

Thus, we believe, the data presented can be taken as representative of the respective groups (native, improved hard, improved soft) since they refer to varieties of wide distribution within each group.

Table IX

Comparative Yields of Wheat Varieties in Experimental Fields

Location	Years of experimentation	Yields in kilograms per stremma			Excess of improved over native		Excess of improved soft over improved hard
		Native	Improved		Hard	Soft	
			Hard	Soft			
COLD AREAS - FERTILE FIELDS							
Ptolemais	12	204	-	320	-	116++	-
	4	161	187	263	26	102++	76
SEMI-FERTILE FIELDS							
Tripolis	13	149	-	183	-	34++	
	3	190	203	210	13	20	7
Dourouti	11	96	-	151	-	55++	-
	5	121	128	169	7	48++	41++
MEDIUM WARM AREAS - FERTILE FIELDS							
Thessaloniki	6	261	-	296	-	35+	-
(Valtos)	5	265	250	301	-15	36+	51++
Nea Zoi	11	307	-	322	-	15	-
	4	336	286	356	-50+	20	70++
Serrai	14	293	-	307	-	14+	-
	5	-	258	326	-	-	68++
	4	329	276	340	-53+	11	64++
Kopais	5	185	228	297	43+	112++	69++
SEMI-FERTILE FIELDS							
Thessaloniki	14	145	177	205	32++	60++	28++
Larissa	15	207	239	254	32++	47++	15
WARM AREAS - FERTILE FIELDS							
Messara	12	212	-	289	-	77++	-
	4	158	217	217	59+	59+	0

Notes on Table IX:

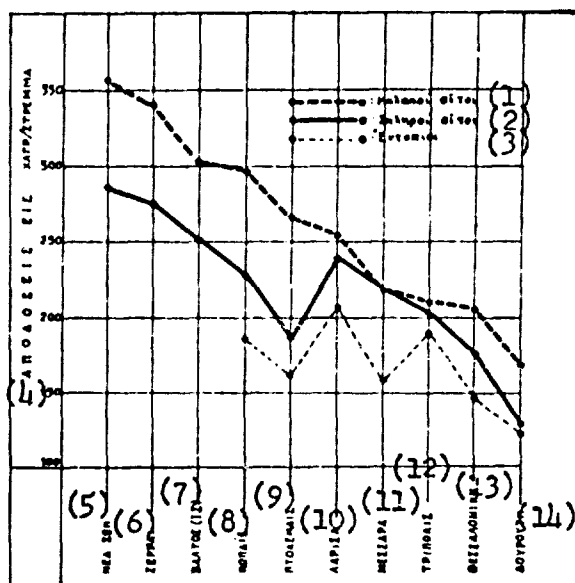
a) In the fertile experimental fields of Thessaloniki (Valtos), Nea Zoi, and Serrai, as native variety was used the improved variety Mentana, which has been cultivated in these areas for thirty years. These areas, before the introduction of Mentana, were cultivated with barley, because there was no native variety of wheat suitable for them.

b) In the experimental fields of Ptolemais and Tripolis, variety I^r - 46025 was used as the improved soft wheat and in all the rest variety I^r - 38290.

c) In the experimental field of Messara, variety I^r - 46049 was used as the improved variety of hard wheat and in all the rest variety Limnos.

Diagram 1

Comparative Yields of Hard and Soft Wheats in Experimental Fields



KEY:

- | | | |
|-------------------------------------|-------------------|-------------------|
| 1 - Soft wheats | 5 - Nea Zoi | 10 - Larissa |
| 2 - Hard wheats | 6 - Serrai | 11 - Messara |
| 3 - Native wheats | 7 - Valtos (I.S.) | 12 - Tripolis |
| 4 - Yields in kilograms per stremma | 8 - Kopais | 13 - Thessaloniki |
| | 9 - Ptolemais | 14 - Dourouti |

To illustrate, in particular, the superiority of the improved hard wheat over the native hard wheat, we transfer from Table IX to Table X the excess yield (in kilograms per stremma) of the former over the latter, in those cases where the control native variety was one of hard wheat.

Table X

Yields (in Kilograms per Stremma) of the Improved
and Native Hard Wheats in Experimental Fields

Locations	Native	Improved	Excess of improved over native
Tripolis (Mavragani)	190	203	13
Dourouti (Rousias)	121	128	7
Kopais (Kontouzi)	185	228	43+
Thessaloniki (Deves)	115	177	32++
Larissa (Deves)	207	254	47++
Messara (Eretria)	158	217	59++

The data of Tables IX and X indicate that:

1. The improved hard wheats exceed in yield the native ones by 7 - 59 kilograms (6 - 36%). This excess is significant (32-59 kilograms per stremma, i.e., 15-36%), in the areas of medium warm to warm temperatures (Thessaloniki, Larissa, Kopais, Messara). It should be noted that in the experimental fields of these areas the native control is a variety of hard wheat and, therefore, we can say that the replacement of native hard wheat by improved in areas best suited to hard wheats brings about an increase in the yield of at least 30 and up to 60 kilograms per stremma.

2. The improved soft wheats exceed in yield the native ones by far more than the hard wheats, and, to be specific, by 34-116 kilograms per stremma (23-61%). This excess is observed in all experimental fields and is considerably larger in the more fertile and colder areas of the country. It should be noted that the conclusions of this as well as of the preceding

paragraph do not refer to the comparison of the yields in the experimental fertile fields of Thessaloniki, Nea Zoi, and Serrai, where the improved variety Mentana was used as the native control.

3. In the experimental field of Messara, in the island of Crete (warm area) the improved variety of hard wheat was equal in yield to the improved soft variety, and in Larissa the former competed with the latter, remaining behind only by 15 kilograms per stremma, or 6%. In all other experimental fields the improved soft wheat exceeded in yield considerably the improved hard one (28-76 kilograms per stremma or 16-41%) with the only exception of Tripolis, for which the data are not complete. This excess is larger in the more fertile and colder areas.

Similar information we also have from the statistical data on yields in the whole country for the period 1957-59, taken from the estimations of the Local Bureaus of Agriculture, which are shown in Table XI.

Table XI

Yields Per Stremma in Greece During the Years 1957-59

Years	Native wheats	Improved wheats		Percent excess of improved over native		Percent excess of soft over hard
		Hard	Soft	Hard	Soft	
1957	112.5	136.1	186.3	21	64	37
1958	117.3	154.0	184.4	31	57	20
1959	112.4	139.9	171.5	24	53	23
Average	114.1	143.3	180.7	26	58	26

Summarizing, then, the above data, we conclude that:

1. The 2 to 1 proportion between the cultivated hard and soft wheats respectively, observed around the year 1930, was due to the fact that the yields of those groups of native varieties were about the same and, since the market prices of the hard wheats were higher, the farmers preferred them over the soft.

2. The rapid decrease in the cultivation of hard wheat, which occupies today an area less than half that of the soft wheat, is due to the development and spreading of the improved varieties, and especially of the improved varieties of soft wheat, which giving yields higher by about 25% than those of the improved hard varieties, were naturally preferred by our farmers. In spite of the higher price of the hard wheats, the soft wheats, by their higher yields, were producing higher economic gains for the farmer, for the same cultivated area.

TODAY'S PRODUCTION AND THE NEEDS OF OUR COUNTRY IN HARD WHEAT

The production of hard wheat in our country during the years 1957-59 is shown in Table XII.

Table XII

Production of Hard Wheat in Greece in the Years 1957-59

Years	Hard wheats, kilograms	Unspecified wheats, kilograms
1957	422,607,366	59,489,881
1958	441,569,539	61,849,076
1959	402,594,400	86,437,600
Average	422,257,102	69,258,822

Thus, the average production of hard wheat in our country was 420,000 tons per year. If we add to this figure part of the unspecified wheats, which are varieties of either hard or soft wheats not specified by the persons collecting the statistical data, we can calculate that the average production of hard wheat in our country in the last few years is of the order of 450,000 tons per year.

What are, on the other hand, the needs of our country in hard wheat? The hard wheat produced in Greece is, of course, completely used up within the country. It is not known, however, what part of it is used in the way the hard wheat should be used, namely for the production of semolinas

and macaroni products, and what part is used - wrongly - by the producers for making bread. We are mentioning here, indicatively, that during the years 1952-54 the Greek industry had an average yearly production of 35,000 tons of macaroni products. This amount should be increased by the addition of the macaroni-like products made by the peasants themselves and by taking into account the progress of this industry in recent years, to 100,000 tons. Considering, then, that for this production not over 150,000 tons of hard wheat are used per year, there is an excess of about 300,000 tons of hard wheat per year left in our country, which apparently is used for bread-making.

OUR FUTURE NEEDS IN HARD WHEAT

In Italy, which is renown for its consumption of macaroni and similar products, and which has a population six times that of our country, the average yearly consumption of hard wheat, locally produced or imported, was 4,267,000 tons in the years 1954-57. This means that in Greece, with the existing population, and if the demand for macaroni products was the same as for the Italians, we should use about 800,000 tons of hard wheat per year. We will never reach this amount, but we could easily reach that of 300,000 tons. In such case, our local production of hard wheat would still leave a large margin for export. This margin could be further increased by the expansion and intensification of the production of hard wheats in our country.

MACARONI PRODUCT CONSUMPTION IN OTHER COUNTRIES AS COMPARED WITH THAT OF OUR COUNTRY

It is estimated that the average consumption of macaroni and similar products per capita in the year 1955 was:

35	kg for Italy
10	kg for Switzerland
6.3	kg for France
3.4	kg for Germany
2.8	kg for the United States
2	kg for Belgium

In our country, if we use the above mentioned production of 35,000 tons of macaroni by our industry, the per capita consumption corresponds to about 4.5 kg. This figure should be increased by the progress that certainly took place in this industry in recent years, and by the per capita proportion of home-made macaroni and pastry goods by the peasants. Then, the per capita consumption in Greece must be at the level of 12 kilograms. Thus, our country comes second, after Italy, in the consumption of macaroni and similar products. And this consumption today seems to be

on an increase, so that one can predict that the figure of 12 kg per capita will be exceeded. This makes it necessary to standardize and organize better the country's production of hard wheats and the more rational use of them; all of the existing data today on the production and uses of hard wheat products clearly indicate that the cultivation of hard wheat and the use of its products is conducted without the guidance that is required.

POSSIBILITIES FOR THE PRODUCTION OF MORE HARD WHEAT

We have already given (Table IX) experimental data indicating that the improved varieties of hard wheat give yields higher by about 30 kg per stremma than the native ones. This excess of 30 kg is also confirmed by the statistical data on the estimated yields of different varieties of wheat in our country during the years 1957-59 (Table XI). Today (average of 1957-59), 1.4 millions of stremmata are still cultivated in our country with native varieties of hard wheat. The simple replacement of these varieties with the best suited for each area improved varieties of hard wheat could increase our yearly production of hard wheat by about 50,000 tons. Another 1.5 million of stremmata are still cultivated with native varieties of soft or unspecified wheat. The replacement of those by improved hard wheats, the average yields of which during the years 1957-59 was 143.3 kg per stremma, means an increase of over 200,000 tons in our production.

This course of action, namely the replacement of the native varieties by improved hard wheats, which, as we mentioned before, could increase our yearly production of hard wheat by 250,000 tons, is, in our opinion, the most profitable both for the national economy and for the farmers. But we know, from experience, that such replacement can proceed only at a slow pace, whereas the need to obtain, from the very beginning, a good position in the international trade of hard wheat is more urgent and requires solutions giving faster results. Such solution is the increase in the cultivation of hard wheat at the expense of the soft, in those areas which on one hand offer a favorable ecological environment for hard wheat, and on the other cultivate almost exclusively wheat. When a farmer's economy is based mainly on one kind of cultivation, he is eager to follow any suggestions that would tend to increase the income from that cultivation. For example, despite the fact that in Crete and the other islands the improved hard wheat gives about the same yield as the soft one, and they are both considerably superior than the native varieties that cover 50-80% of the total wheat-growing land in this areas, we cannot expect the farmers to show an immediate interest in the production of hard wheat; the expected gain from such a conversion of their wheat cultivation would improve their total economy to a very small extent, since the latter is based mainly on other kinds of cultivation. But even if the conversion in these areas

were to take place immediately, again the contribution to the hard wheat trade would be very small, if not negligible, because the wheat production in these areas can usually cover just a small part of the needs of the farmers themselves.

On the contrary, in Thessaly, for example, where the farmer's economy is based mainly on wheat, the farmers can turn immediately to the cultivation of hard wheat, if convinced that such a turn will increase their income from wheat-growing. For their personal economy, this means an equal increase of their total income, since the latter is derived almost exclusively from wheat-growing. For the governmental program, on the other hand, such a conversion would mean the immediate offer of large quantities for export.

The experimental data presented above indicate that, with the exception of the cold areas, the hard wheat competes successfully with the soft in semi-fertile soils of relatively low moisture retention. Such soils constitute the larger part of the 11 million stremmata cultivated today with wheat in our country. This means that there are vast possibilities for an expansion of the cultivation of hard wheat above the 3.2 million stremmata that it occupies today, by partial displacement of the soft wheat. To achieve a production as high as the needs for export would require, should be considered rather easy.

In addition to the quantities of hard wheat that would be obtained from an increase in the cultivated areas, considerable quantities of hard wheat could become available if our farmers were persuaded not to use hard wheat for making bread.

An intensive effort, along these lines, to convince our farmers about the qualitative inferiority of bread made from hard wheat as compared to bread made from soft wheat, and, if possible, a more attractive price difference between hard and soft wheats, would make available for export large quantities, even from the expected crop of 1962.

POSSIBILITIES OF IMPROVEMENT OF THE CULTIVATION AND PRODUCTION OF HARD WHEATS

It becomes evident, from what we have discussed so far, that an expansion of the cultivation of hard wheats in our country would be very easy and would inevitably result in a considerable increase in the production of hard wheats and in the creation of stocks for export. We believe that the increased production of hard wheats and their export would result in a real and substantial change in the economy of many areas of the country, if, concomitantly with the increase in total production, measures were taken aiming at the following goals:

1. An increase in the yields per stremma of the cultivated hard wheats.
2. An improvement of the quality of the hard wheat production and especially of the exported lots.
3. A standardization of the production of hard wheats and their classification into various categories with strictly kept specifications.
4. A programming of the exports of the stocks of hard wheats to be created.

The increase of the yields of the hard wheats and the improvement of their quality can be brought about by taking the necessary measures, namely:

1. By making compulsive the gradual replacement of the native varieties of both hard and soft wheats by improved varieties of hard wheat, while making, at the same time, every effort to achieve the highest possible yields by applying the appropriate, improved techniques of cultivation. This effort should be reinforced by guidance of the farmers and by material and moral support, namely by awarding loans, prizes and other material and moral rewards.
2. By promoting the cultivation of hard wheat only in those soils, and in those areas in which the hard wheats, when cultivated, yield a protein of excellent quality with excellent plastic properties. The cultivation of hard wheats in very fertile and moisture retaining fields must be avoided, since in the soil of such fields, the hard wheats cannot compete with the soft ones and give products of inferior quality. Cultivation of hard wheats in fields not suitable for the production of hard wheats of excellent quality would create a big problem, because it would become very difficult to sell the wheats produced in rich and moist soils to the industries, both local and foreign.
3. By making the use of fertilizers for hard wheats compulsive and, if possible, supervised in every aspect.
4. By making sure that the harvesting of the hard wheats takes place at the time at which the proteins and most of their properties are in the best possible shape, since it has been conclusively proven that the time of harvesting has a considerable effect on the quality of the gluten and on its plastic properties.

NEW IMPROVED VARIETIES ON WHICH THE DEVELOPMENT OF THE CULTIVATION
OF HARD WHEAT MUST BE BASED

The use, to the present day, of native varieties of hard wheat in our country (Table II) and their incomplete replacement must also be attributed, to some extent, to the fact that the improved varieties of hard wheat by which the replacement of the native ones was attempted, were, in some cases, not the best suited for that purpose; they were a little late-ripening and had wintry properties, which hindered their spreading in the southern areas, whereas in the northern parts of the country, for which these varieties were best suited, their spreading is almost complete. However, what was not accomplished with the older improved varieties, we are confident that will be accomplished with the new ones; by crossing the variety Limnos with some others we have obtained progenies which, although retaining the good properties of Limnos, do not have its disadvantages and especially the late-ripening, which was the factor that hindered its spreading in the southern areas. These new varieties, known from our previous publications, are the following:

1) I - 58128, resulting from a cross between the varieties S. Capelli X (Limnos X [(Florence X Arditto) X Sinai]).

2) I - 58301, resulting from a cross between the varieties Limnos X I - 44142 (Variety I - 44142 is a pre-war cross from unknown parent varieties).

3) I - 46049 resulting from a cross between the varieties Limnos X (Florence X Arditto) X Sinai.

All above varieties ripen 8 to 13 days earlier than variety Limnos and we predict that it will be possible to replace by them all native varieties of both hard and soft wheats in Thessaly, Sterea, Peloponnese and the Aegean Islands. In addition, in Northern Greece, variety I - 58301 can replace in most cases variety Limnos; this is desirable because of the better agronomic properties and especially the better quality of the former. All new improved varieties mentioned above give high yields, competing successfully with those of Limnos.

Table XIII gives good evidence of the yields obtained with the above varieties of hard wheat. The average yields of these varieties are compared with those of Limnos in the network of experimental fields.

Table XIII

Comparative Yields of Improved Varieties
of Hard Wheat in Experimental Fields

Location	Years of experi- menta- tion	Yields in kilograms per stremma				Differences from Limnos		
		Limnos	46049	58128	58301	46049	58128	58301
COLD AREAS - FERTILE FIELDS								
Ptolemais	4	187	-	155	165	-	-32	-22
	3	191	117	-	-	-74	-	-
SEMI-FERTILE FIELDS								
Tripolis	3	203	183	197	201	-20	- 6	- 2
Dourouti	5	128	-	126	125	-	- 2	- 3
(Ioanninon)	4	133	123	-	-	-10	-	-
MEDIUM WARM AREAS - FERTILE FIELDS								
Thessaloniki	5	250	-	274	254	-	24+	4+
(Valtos)	4	258	273	-	-	15+	-	-
Nea Zoi	4	286	-	298	286	-	12+	0
(Thessaloniki)	3	277	301	-	-	24+	-	-
Serrai	5	258	-	229	245	-	-29	-13
	4	252	247	-	-	- 5	-	-
Kopais	5	228	-	204	225	-	-24	- 3
	4	235	216	-	-	-19	-	-
SEMI-FERTILE FIELDS								
Thessaloniki	12	187	200	-	-	13+	-	-
	8	194	-	-	206	-	-	12+
	7	195	-	202	-	-	7+	-
Larissa	9	256	258	-	-	2+	-	-
	7	259	-	254	252	-	- 5	- 7
WARM AREAS - FERTILE FIELDS								
Messara (Crete)	5	175	-	221	206	-	46++	31+
	4	157	217	-	-	+60++	-	-

From the data of Table XIII it is concluded that in the northern and warmer parts of the country (Messara - Crete), the superiority of the yields of the new varieties over those of Limnos is clear-cut, whereas in the colder areas (Ptolemais), Limnos is definitely superior. Between these two extremes, in the medium-warm areas of the country, the new varieties appear to be equal in yield to Limnos.

OUTLOOK FOR THE CREATION OF VARIETIES OF HARD WHEAT OF BETTER QUALITY AND HIGHER YIELD

Of course, the efforts of the Grain Institute for the improvement of the Greek hard wheat did not stop with the creation of the above mentioned varieties. New crosses were tried and new biotypes were created which are being tested in a large network of experimental fields to determine their yields and their general agronomic properties. At the same time, these new varieties are being examined in our technological laboratory for an evaluation of their quality. From the data collected so far, both in the field and the laboratory, on the new biotypes, the outlook seems very good for the cultivation of some of them in a large scale in the near future.

TECHNOLOGICAL VALUE OF THE DEVELOPED VARIETIES OF IMPROVED HARD WHEAT

Our examination of the technological value of the hard wheats has shown that, qualitatively, the new varieties stand very well and that there is still room for their further improvement by the selection of the best suitable fields for their cultivation, the use of the appropriate fertilizers and by the correct handling of the question of harvesting.

The data collected in the technological study of the above hard wheats are summarized in Table XIV. These data refer to the weight of 100 liters, the weight of 1000 grains, the percentage of hyaline grains, the percentage of proteins, the ash, the semolina, and the extensigraphic energy, as well as the maximum height of the respective diagram.

Table XIV
Comparative Chemical-Technical Data on the Value
of Greek Varieties of Hard Wheat

Locations and Varieties	On wheat						On semolina			
	Color of grain	Weight of 100 liters	Dry weight of 1000 grains	Hyaline grains	Protein (% of dry weight)	Ash (% of dry weight)	Yield in semolina	Extensi- ography		b-Carotene (p.p.m. of dry weight)
								Energy	Maximum height	
Thessaloniki - (semi-fertile)										
Limnos	A	76.5	38.7	84	11.17	1,453	53.2	19.5	320	7.49
I - 46049	B	77.7	42.1	85	9.28	1,597	52.0	36.0	380	5.85
I - 58128	B	77.5	48.9	95	13.70	1,587	52.0	51.0	480	4.98
I - 58301	B	76.5	38.2	88	11.42	1,625	52.3	40.0	360	5.87
Larissa										
Limnos	B	79.5	42.3	66	10.54	1,291	44.8	12.5	220	6.31
I - 46049	A	-	38.8	29	10.29	1,243	-	-	-	-
I - 58128	A	80.5	40.1	88	11.83	1,383	47.6	44.0	460	5.22
I - 58301	A	81.	40.6	79	11.02	1,509	48.2	28.5	360	-
Dourouti (Ioanninon)										
Rousias	A	-	50.7	27	10.43	2,091	-	-	-	-
Limnos	A	-	49.4	28	9.98	1,934	-	-	-	-
I - 46049	A	78.2	48.1	21	9.85	1,910	45.5	12.0	260	10.63
I - 58128	A	81.	46.5	44	10.57	1,804	51.9	34.0	380	7.53
I - 58301	B	81.	43.7	57	10.41	1,768	51.4	28.0	360	9.09
Messara (Crete)										
Eretria	Δ	78	50.6	83	12.60	1,725	48.0	28.5	380	5.35
Limnos	B	80	50.5	88	11.82	1,579	50.0	12.0	300	5.16
I - 46049	B	80	48.4	71	9.78	1,501	50.5	27.0	380	5.19
I - 58128	B	80.5	48.1	94	13.00	1,673	51.5	42.5	420	4.72
I - 58301	A	81.5	48.1	91	12.36	1,596	52.0	35.5	420	5.49
Kopais										
Limnos	B	-	43.2	40	9.61	1,870	-	-	-	-
I - 46049	B	-	43.1	58	10.91	1,998	-	-	-	-
I - 58128	B	78.5	43.1	63	12.75	1,994	47.3	20.0	260	5.07
I - 58301	B	79.5	40.7	57	10.45	1,842	44.0	14.0	240	4.76

Note: The color of the grain is indicated as follows:

A = Yellow, B = Amber, Δ = Dark red.

On the basis of these data the improved varieties of hard wheat can be classified, in terms of quality, in the following order:

- I variety T - 58128
- II variety T - 58301
- III variety Limnos
- IV variety T - 46049

This data also show that some of the new varieties of our Institute possess the basic features required for their promotion in the world trade, and that they can compete with the varieties of hard wheat of Canada and America, if the good properties that they exhibit are reinforced by taking all the necessary measures during cultivation and harvesting.

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BIBLIOGRAPHY

1. S. L. Papandreou, Special Agriculture, Athens, 1954.
2. B. G. Christidis, The Large-Scale Cultivations, Thessaloniki, 1950.
3. D. Kavvadas, Plant Biology, Athens, 1951.
4. I. S. Papadakis, Greek Varieties of Wheat, Thessaloniki, 1929.
5. S. L. Papandreou, On the varieties of wheat cultivated in Greece in 1930-31 and 1933-34, Athens, 1935.
6. P. Kanaginis, The varieties of wheat cultivated in Greece (cultivation year 1938-39), Athens, 1940.
7. B. F. Kokolios, The varieties of cereals cultivated in Greece (cultivation year 1945-46), Athens, 1948.
8. B. F. Kokolios, The varieties of wheat cultivated in Greece in year 1956-57 and 1957-58, Thessaloniki, 1959.
9. B. F. Kokolios, The hard and soft wheats cultivated in Greece, Thessaloniki, 1960.
10. Ministry of Commerce, A Study of the Greek Wheat of 1959, Athens, 1961.
11. Italian Institute of Statistics, Annuario di Statistica Agraria, Roma, 1958.
12. V. Carrande, La productione del grano duro nel mondo, Foggia, 1961.